REPORT 13 OF THE COUNCIL ON SCIENTIFIC AFFAIRS (A-04)
Mercury and Fish Consumption: Medical and Public Health Issues
Resolution 516 (A-03)
(Reference Committee E)

EXECUTIVE SUMMARY

Objective: To provide information on the environmental life cycle and human toxicology of mercury, explain the development of the national joint Food and Drug Administration (FDA)-U.S. Environmental Protection Agency (EPA) consumer fish consumption advisory, briefly review key epidemiological studies of mercury (Hg) exposure and childhood development, and discuss other scientific issues relevant to dietary seafood and freshwater fish consumption.

Methods: This report summarizes the key findings of the April 2004 Conference on Mercury: Medical and Public Health Issues, co-sponsored by the EPA and the U.S. Department of Health and Human Services. Additional information was obtained by direct communication with experts in the field.

Results: Release of Hg from the global crust secondary to mining, burning of fossil fuels, incineration of medical and municipal waste, and other sources resulting from human activity have increased the rate of Hg release into the environment. Once in the environment, interconversion between the different forms of Hg occurs. Inorganic Hg that is deposited is converted to organic Hg by microorganisms or abiotic processes, particularly in aquatic sediment. The predominant organic form, methylmercury, is concentrated in the food chain in aquatic systems, especially in larger predatory fish. Methylmercury is neurotoxic. The level of fish consumption correlates with the body burden of Hg. Although fish consumption provides cardioprotective effects, higher levels of fish consumption also have been associated with subtle neurodevelopmental effects. In response, national consumer fish consumption advisories have been crafted in an effort to protect high-risk populations (pregnant women, women who intend to become pregnant, and young children) from excessive Hg exposure.

Conclusion. Women who might become pregnant, are pregnant, or who are nursing should follow federal, state, and local advisories on fish consumption. Because these advisories may differ, the most protective advisory should be followed. Physicians should assist in educating patients about the relative mercury content of fish and shellfish products, and make them aware of current advisories on fish consumption. Testing of the mercury content of fish should be continued by appropriate agencies and results should be publicly accessible and reported in a consumer-friendly format. Given the limitations of national consumer fish consumption advisories, the FDA also should consider the advisability of requiring that fish consumption advisories and results related to mercury testing be posted where fish, including canned tuna, are sold.

REPORT OF THE COUNCIL ON SCIENTIFIC AFFAIRS

CSA Report 13-A-04

Subject: Mercury and Fish Consumption: Medical and Public Health Issues (Resolution 516, A-03)

Presented by: J. Chris Hawk, III, MD, Chair

Referred to: Reference Committee E (Stuart Gitlow, MD, Chair)

Resolution 516 (A-03), introduced by the California Delegation and referred to the Board of Trustees (BOT) for decision, asked that our American Medical Association (AMA) (1) encourage that testing of mercury content in food, including fish, be continued by appropriate agencies, and laboratory reporting of results of mercury testing be updated and consistent with current Environmental Protection Agency (EPA) and National Academy of Sciences standards; (2) work with the Food and Drug Administration (FDA) to determine the most appropriate means of testing and labeling of all foods, including fish, to determine mercury content and encourage that the results and advisories of any mercury testing of fish should be readily available where fish are sold, including labeling of packaged/canned fish; and (3) encourage physicians to educate their patients about the potential dangers of mercury toxicity in some food and fish products, especially those products that are well documented to contain mercury, and to advise pregnant women to limit, and parents to limit their children's, consumption of such products.

At the time that Resolution 516 (A-03) was referred for decision, the FDA and EPA were in the process of drafting a joint consumer advisory on fish consumption. Accordingly, the BOT agreed that our AMA should monitor the public meeting and progress of the joint advisory, and respond as appropriate. Additionally, the BOT instructed the Council on Scientific Affairs to prepare a report informing the House of Delegates once the advisory was finalized, to assist in educating physicians and consumers on the medical and public health issues related to mercury exposure from fish consumption.

In late April 2004, our AMA, the American Academy of Pediatrics, the American College of Preventive Medicine, and the American Association of Public Health Physicians partnered with the EPA and the U.S. Department of Health and Human Services (DHHS) to develop a state-of-the art conference on mercury. This report reviews the findings of this conference and provides some background information on the environmental life cycle and human toxicology of mercury, explains the development of the national joint FDA-EPA consumer fish consumption advisory, briefly reviews key epidemiological studies of mercury exposure and childhood development, and discusses other scientific issues relevant to dietary seafood and freshwater fish consumption. Finally, the report offers recommendations for AMA policy on this issue.

This report does not address the two other major sources of mercury exposure for the general population, namely ethylmercury from thimerosal-containing vaccines and dental amalgam, nor the ritualistic/religious use of mercury, which may increase mercury exposure in selected populations.[1] The former is discussed in BOT Report 14 (A-04), and is also evaluated in a recent report from the Institute of Medicine.[2] The use of dental amalgam remains an occupational issue for general care dentists who provide mercury-based dental fillings. Dental amalgam emits

mercury vapor that can be inhaled and absorbed into the blood stream, in particular during installation and/or removal. A correlation exists between the number of dental amalgams and blood mercury concentrations, but the increases are small (approximately doubling the background rate), and do not appear to pose a hazard for most patients.[3] A number of comprehensive evaluations, reports, and reviews have been conducted on this subject over the last 10 years. According to the FDA, "no valid scientific evidence has shown that amalgams cause harm to patients with dental restorations, except in the rare case of allergy."[4] The National Institute of Dental & Craniofacial Research continues to study the issue. The Children's Amalgam Trial, which will evaluate IQ scores, neuropsychological assessments, and renal function in amalgam recipients is ongoing.[5]

Methods

This report summarizes the key findings of the April 2004 Conference on Mercury: Medical and Public Health Issues, co-sponsored by the EPA and DHHS.[6] Additional information was obtained by direct communication with experts in the field.

Background

Sources of Mercury and Mercury Exposure. Mercury exists in the elemental form (Hg^0), and in various inorganic and organic complexes (Hg^{+1},Hg^{+2}), which differ in toxicity. Primary exposure to elemental Hg in the general population is via inhalation of vapors from dental amalgams, which are ~50% Hg. In the absence of fish consumption, body burdens of Hg correlate with the number of amalgam surfaces present. The presence of 10 amalgam surfaces approximately doubles the background mercury concentrations found in the urine.[3] Inhaled Hg is oxidized to Hg^{2+} (mercuric Hg) by catalase in red blood cells. Because Hg is lipophilic, a portion enters the brain prior to oxidation. The half-life of Hg vapor is approximately 60 days. Elemental Hg is excreted as Hg^0 in exhaled air, sweat, and saliva, and as mercuric Hg in feces and urine.

Inorganic Hg is found in disinfectants, vapor lamps, photography supplies, cosmetics, embalming fluids, etc. The soluble inorganic salts (eg, $HgCl_2$) undergo some gastrointestinal absorption, but do not penetrate the central nervous system (CNS) readily in adults. The relative degree of CNS penetration is higher in the fetus and neonate. In adults, the highest concentration of inorganic Hg is generally found in the kidney. The metal is excreted in the urine and feces, with a half-life of 40 to 60 days.

The major organic mercury forms are methylmercury (MeHg) found principally in fish, and ethylmercury (thimerosal), which is still used in various pharmaceutical products as a preservative (antiseptics, influenza vaccine, Rhogam®, immune globulin, injectable testosterone, contact lens solutions and ophthalmic ointments, nasal sprays, and ear drops). A list of medications that contain thimerosal can be found at www.fda.gov/cder/fdama/mercury300.htm. Organic mercurials are lipid soluble, are well absorbed from the gastrointestinal tract, and readily penetrate cell membranes, including the blood-brain and placental barriers. Movement into the CNS may be assisted via the formation and transport of MeHg-cysteine complexes. MeHg slowly demethylates to mercuric Hg, which is only slowly eliminated from the brain. The daily excretion of MeHg is approximately 1% of the body burden, and is accomplished primarily via the biliary-fecal route, with a half-life of approximately 70 days. Elimination from the brain is slower. Based on data obtained from monkeys, the elimination of ethylmercury has been determined to be considerably faster than that of MeHg.[7]

Mercury is a global pollutant that cycles in the environment as a result of both natural phenomena and human activities. Environmental mercury is derived from the weathering or mining of rock containing Hg ore (ie, HgS or cinnabar) and from sources related to human activity, particularly the incineration and burning of fossil fuels. Major man-made sources of elemental Hg include coal-burning utility plants and certain mercury-containing products (eg, thermometers, sphygmomanometers, lamps, batteries, electronic switches and devices). Release of Hg from the global crust secondary to mining, burning of fossil fuels, incineration of medical and municipal waste, and other anthropogenic releases resulting from human activity have increased by a factor of 2 to 5 times the rate of Hg release compared with pre-industrial times. The EPA has estimated that those sources account for 50% to 75% of the total yearly input of Hg into the atmosphere, principally from medical and municipal waster incinerators and coal-fired utility boilers.[8]

Accordingly, on January 30, 2004, the EPA issued a proposed rule to substantially cut mercury emissions from coal-fired power plants.[9] The Utility Mercury Reductions proposal would cut mercury emissions by nearly 70% when fully implemented. This proposal would permanently cap emissions from coal-fired power plants and provide companies with flexibility to achieve early reductions of mercury. The EPA proposed two alternatives for controlling mercury. One approach would require power plants to install controls known as "maximum achievable control technology" under Section 112 of the Clean Air Act. If implemented, this proposal would reduce nationwide mercury by 14 tons or about 30% by early 2008. A second approach proposed by the EPA would create a market-based "cap and trade" program that, if implemented, would reduce nationwide utility emissions of mercury in two phases.[9,10] When fully implemented mercury emissions would be reduced by 33 tons (nearly 70%). States may choose to adopt the cap-and-trade program to achieve and maintain the necessary emission standards.

Once in the environment, interconversion between the different forms of Hg occurs, with sequences of emission, deposition via particles or precipitation, and revolatization. After deposition, conversion of inorganic to organic mercury is accomplished by microorganisms or abiotic processes, particularly in aquatic sediment. Once in its predominant organic form (MeHg), bioaccumulation occurs. Thus, Hg, particularly MeHg, is an established, worldwide environmental pollutant and is concentrated in the food chain in aquatic systems, especially in larger predatory fish. The amount of MeHg in any given seafood or freshwater fish depends on the species, its age/size, and the waters from which it came. An in-depth analysis of the fate and transport of Hg can be found in the U.S. EPA's 1997 Mercury Study Report to Congress.[8]

Human Health Effects of Methylmercury

There is general consensus that the critical organ for MeHg toxicity is the brain.[11] The developing nervous system is more susceptible than the adult nervous system. Clinical poisoning episodes in Japan following the industrial release of MeHg into aquatic systems and in Iraq following consumption of contaminated bread established mercury as a neurotoxic agent.[12-14] Severe effects in humans occur following such poisonings and may cause death or a pattern of neurotoxic effects including paresthesia, ataxia, blurred vision/blindness, tremors, impairment of hearing/deafness, slurred speech, and difficulty walking. More recently, mercury contamination related to gold mining operations in the Amazon river basin has been associated with abnormal motor and visual function.[15]

Fetal exposure to large amounts of MeHg from maternal consumption of fish results in a pattern of severe neurodevelopmental defects and fatalities. Chronic low-dose prenatal MeHg exposure from maternal consumption of fish has been associated with more subtle decrements in several

measures of neurological development, which may resemble a number of learning disabilities present in the overall population of children.[16]

Fish Consumption and Childhood Neurodevelopment. Because of concerns about the range of Hg exposure worldwide, several cross-sectional and longitudinal studies have been done to evaluate the effects of chronic low-dose exposures to MeHg.[17-24] During the past 15 years, results from three prospective epidemiological studies involving populations who had dietary dependence on fish and marine mammals have expanded what is known about the lower range of the dose-response curve for MeHg and effects on the CNS.

A study of 237 children in New Zealand born in the early 1980s and who were tested at ages 4 and 6 years found that scores on the Denver Developmental Screening Test (DDST) were significantly lower in those whose mothers had mercury hair concentrations exceeding 6 ppm.[19,20] The DDST is a standardized test for childhood mental and motor development.

A Faroe Islands cohort of 1022 consecutive births in 1986-1987 was followed up at age 7 and 14 years. Subjects had mixed exposure to polychlorinated biphenyls (PCBs) and MeHg from fish and whale meat consumption. At age 7, cord blood Hg concentrations were correlated with deficits in language, attention, and memory, as well as increased blood pressure, decreased heart rate variability, and decreased auditory-evoked potentials. Additionally, maternal hair Hg was correlated with deficits in the children's fine motor control, and the children's blood and hair Hg correlated with the presence of visuospatial deficits. At the age 14 years follow-up, cord blood Hg was correlated with delayed brainstem auditory-evoked potentials, and decreased heart rate variability.[21-24]

The Seychelles Child Development Study enrolled a cohort of 779 mother-child pairs in 1989-1990. In the Seychelles, women of childbearing age consume fish containing similar concentrations of MeHg to those in the United States (~0.3 ug/g), but with an average of 12 fish meals per week. Prenatal exposure to MeHg was determined by measuring total Hg in maternal hair growing during pregnancy. Children were assessed at 6, 16, 29, and 66 months of age and then again at 9 years of age using tests of global intelligence and developmental milestones.[24] In this study, prenatal Hg exposure was associated with decreased performance on the grooved pegboard test using the nondominant hand in males, and with improved scores in the hyperactivity index of the Conner's teacher rating scale. No differences were observed in other tests, including tests of cognitive function that had previously yielded significant associations in the Faroe Islands study.[25]

Several explanations have been advanced for the differences observed between these cohorts including differences in exposure measurement (ie, cord blood in the Faroe Islands; maternal hair in the Seychelles) and possible interactions with pollutants (such as PCBs) present in whale meat and blubber for Faroe Island subjects. Additionally, protective effects of other factors in fish, such as omega-3 fatty acids (see below), may have been operating in the Seychelles, where the total fish intake was high but Hg fish content was low. Interaction between PCBs and Hg may only occur at higher Hg levels.

Nutritional and Medical Considerations with Fish Consumption

Fish are an excellent source of protein and certain vitamins and minerals. A growing body of literature suggests that diets higher in α-linolenic acid, eicosapentaenoic acid (EPA), and docosohexaenoic acid (DHA) that are found in fatty fish may afford some degree of protection against cardiovascular disease. Fish consumption has been associated with a lower risk of

coronary heart disease (CHD) in some but not all studies. A recent meta-analysis of cohort and case-control studies confirmed that fish consumption is associated with a significantly lower risk of fatal myocardial infarction and total burden of CHD.[26] Additionally, randomized controlled trials have shown that approximately one gram per day of EPA and DHA from a dietary supplement or fish consumption decreases the risk of death from CHD and stroke in patients who have suffered a myocardial infarction.[27-29]

Meanwhile, some data suggest that the Hg body burden may be a risk factor for cardiovascular disease. Even though most studies have suggested an association between high fish intake and reduced mortality from CHD, men in Eastern Finland who have a high fish intake, also have high CHD mortality. In one study, increased hair Hg concentrations were associated with an increased risk of cardiovascular deaths among men aged 42 to 60 years in Finland, in association with increasing consumption of non-fatty fish.[30] In a more recent case control study, toenail Hg concentrations were positively correlated with myocardial infarction rates.[31] However, findings from the Health Professionals' Follow-up Study did not support an association between total mercury exposure (based on toenail Hg) and the risk of CHD, and in another study, there was a strong inverse association between the risk of first myocardial infarction and the biomarkers of fish intake, including erythrocyte Hg concentrations.[32,33] Differences in these studies may involve the relative importance/interaction with contaminants, such as mercury and PCBs, nutrients such as omega-3 fatty acids, and anti-oxidants such as selenium, vitamin C, and vitamin E.

Road to Current National Fish Consumption Advisory

In the late 1990s, the EPA issued two reports on Hg to Congress. One report issued in 1997 evaluated mercury exposures in the United States, potential harmful effects, and the feasibility of control technologies.[8] The second, which was issued in 1998, evaluated the role of utility companies as a source of Hg contamination.[34]

Based on emerging concerns about chronic low-level exposure to Hg and potential adverse effects of MeHg on the adult cardiovascular and central nervous system, the National Research Council under contract from the EPA convened the Committee on Toxicological Effects of MeHg to re-evaluate the issue of mercury exposure. Among other things, the Committee was charged with providing guidance to the EPA on calculating an appropriate exposure reference dose (R*f*D), which represents an estimated daily intake that is likely to be without appreciable risk of harmful effects. The Committee concluded that neurodevelopmental deficits represented the most sensitive effects, and that the R*f*D should be derived based on the principle of fetal protection. Furthermore, the Committee recommended that the Faroe Islands study be used for deriving an R*f*D given that it was a larger study, had more extensive peer review, and used two measures of exposure. Ultimately, the Committee validated the EPA's previous R*f*D of 0.1 ug/kg/day as a scientifically appropriate value that adequately protects public health. The Committee's report was published in 2000.[35] In 2001 the EPA reconfirmed an R*f*D of 0.1 µg/kg/day for MeHg; the corresponding blood concentration is 5.8 µg/L.

While the numerical value of the R*f*D was not modified, the basis for its determination was different in that it was based on a study of fetal MeHg exposure resulting from maternal intake of whale meat and fish for a cohort of children from the Faroe Islands. This derivation used a series of benchmark dose analyses. The primary measure of exposure was umbilical cord blood Hg concentrations. Analyses were performed for a number of endpoints from the Faroe Islands, Seychelles Islands, and New Zealand studies. Derivation of potential R*f*Ds from a number of endpoints from the Faroe Islands study converged on 0.1 ug/kg/day, as did the integrative analysis of all three studies.

Mercury Exposure in U.S. Women and Children

Contemporary data on mercury exposure in U.S. women and children are available from the National Health and Nutrition Examination Survey (NHANES). This cross-sectional national survey conducted by the Centers for Disease Control and Prevention (CDC) is designed to assess the health and nutritional status of adults and children in the United States. A mercury component was added in 1999, which assessed children 1 to 5 years of age, and women aged 16 to 49 years for mercury concentrations and dietary histories related to fish consumption. The objective was to describe the distribution of Hg blood concentrations in U.S. children and women of childbearing age and its association with sociodemographic characteristics and fish consumption.

Based on analysis of these data, measures of Hg exposure in women of childbearing age and children aged 1 to 5 years generally fall below levels of concern.[36] However, approximately 8% of women of childbearing age have blood mercury concentrations exceeding those associated with the EPA's R*f*D (5.8 ug/L). Values were 4-fold higher in those who had eaten fish in the last 30 days. NHANES could not examine geographic variation, and was not designed to provide estimates for groups that may be at increased risk of exposure. Nevertheless, extrapolating the NHANES data to the overall U.S. population suggests that more than 300,000 newborns each year in the United States will have blood mercury concentrations greater than those associated with the EPA's R*f*D.

Regional and population variations may be significant. In a one-year survey of an internal medicine practice in San Francisco, a substantial fraction of patients had diets high in fish consumption; of these, a high proportion had blood mercury levels exceeding the maximum level recommended by the EPA. The mean level for women in this survey was 10 times higher than the mercury concentrations found in the CDC population survey; some children were >40 times the national mean.[37]

Joint National Consumer Advisory on Fish Consumption

In 2001, the FDA and EPA issued national consumer advisories on fish consumption. The EPA advisory focused on recreationally caught freshwater fish. The advisory applied to areas where states had not provided specific guidance on untested waters. Consumers were instructed to check with state or local health departments for advice on waters where family and friends fish. Guidances are contained within the National Listing of Fish and Wildlife Advisories database, which includes all available information describing state, tribal, and federally issued fish consumption advisories in the United States for the 50 states, the District of Columbia, and four U.S. Territories, and in Canada for the 12 provinces and territories. The database contains information provided to the EPA; however, the scope of warnings issued by states varies considerably. The EPA's advisory warned women who are pregnant, or may become pregnant, and nursing mothers to limit their fish consumption to just 6 ounces per week (cooked) and to 2 ounces for children. The EPA recommended following the FDA's advice for ocean/commercial fish.

The 2001 FDA advisory addressed pregnant women and women of childbearing age who may become pregnant on the hazard of consuming certain kinds of fish that may contain high levels of MeHg. The FDA advised these women not to eat shark, swordfish, king mackerel, and tilefish. The FDA also recommended that nursing mothers and young children not eat these fish.

Otherwise, consumers should limit consumption of fish to an average of 12 ounces per week and follow the EPA advisory for recreationally caught fish.

In July 2002, the FDA's Food Safety Committee was asked to evaluate whether the FDA consumer advisory was adequate to protect pregnant women and women of childbearing age who may become pregnant. The Committee recommended a series of policy changes that included:

- better define what is meant by "eat a variety of fish" so that consumers can follow this recommendation effectively;
- work with other federal and state agencies to bring commercial and recreational fish under the same umbrella;
- publish a quantitative exposure assessment used to develop the advisory recommendations;
- develop specific recommendations for canned tuna, based on a detailed analysis of what contribution canned tuna makes to overall methylmercury levels in women;
- address children more comprehensively in the advisory to relate dietary recommendations in the advisory to the age/size of the child; and
- increase monitoring of methylmercury to include levels in fish and the use of human biomarkers.

These challenges were met for the most part. New monitoring data for MeHg in fish were compiled by the FDA in 2003 (see Table). In March 2004, the FDA and EPA released their joint advisory entitled: "What You Need to Know about Mercury in Fish and Shellfish-2004 EPA and FDA Advice for: Women who might become pregnant; Women who are pregnant; Nursing mothers; Young children." The joint advisory (see Appendix) has three main elements–a risk message; consumer advice; and additional information in the form of Frequently Asked Questions. This document is available at http://www.cfsan.fda.gov/~dms/admehg3.html.

The advisory is designed to balance the positive benefits of fish consumption with information on how to be confident that exposure to the harmful effects of mercury has been reduced, including information on which fish to choose via a list of lower Hg-containing fish.

Regional Fish Advisories

Advice regarding fish consumption is also relevant for regional advisories that apply to sport fish. The states and various federal programs have measured total Hg in fish and shellfish for several decades. Methylmercury comprises >90% of the mercury in fish tissue. Regional atmospheric sources may influence local water bodies and fish to the extent that commercial guidelines are not a good substitute for local fish advisories. The EPA maintains a Website that links to state fish advisories, making it fairly easy to find state advisories and information on fish from individual waterways within each state (www.epa.gov/ost/fish/states.htm). As new data on Hg in fish and shellfish are collected, and as new human health effects studies are completed, consumption advisories are periodically updated and refined. Regional advisories also have information on other important contaminants such as PCBs and dioxin.

Various means are used to transmit regional fish advisories to the public. Some states post warning signs at boat ramps and public fishing piers located at "hot" spots. The primary means of distributing the state or regional consumption advisories are by Internet Websites, which have the consumption advisories online and available as downloadable brochures. Some states issue their brochures with fishing licenses.

Little information is available on the effectiveness of these fish consumption advisories. It is important to know whether the general population is aware of these advisories and reduces consumption of contaminated fish by reducing its consumption of all fish, which would reduce the nutritional benefits of fish consumption. For example, a 12-state survey conducted in 2001 by the Consortium for Improving the Effectiveness of Mercury Fish Consumption Advisories found that only 20% of women of childbearing age were aware of mercury fish consumption advisories and basic information regarding mercury toxicity.[38] Institution of a new risk communication strategy led to some improvement in overall awareness.

National data on Hg concentration by species may not be applicable on a state or local scale. Different species from different oceans enter the U.S. through different ports and enter a complex distribution network. It is therefore important to compare state and local data on Hg concentrations to the national data.

Summary and Discussion

Divergent data from prospective epidemiological studies of maternal Hg exposure and childhood neurodevelopment, as well as concerns about Hg as a risk factor for both cardiovascular disease and neurodegeneration in adults, have prompted a reexamination of medical and public health issues related to Hg. A number of risk assessments have been conducted to inform government and public health decision-making to protect consumers through regulations on acceptable concentrations of Hg in fish, decisions on the regulation of electric power utilities that release mercury during the burning of fossil fuels, and the creation of fish advisory programs by state and local public health and environmental agencies.

Challenges remain in characterizing population risks, communicating individual risks, addressing adverse health effects, and implementing effective preventive measures. Consumers are confronted with multiple sources of advice and methods for communicating that advice from government agencies, states, local health departments, physicians, other health care providers, environmental advocates, scientific articles, and the media. Because of the complexity of the message, cultural and literacy barriers are formidable. The challenge is to provide information about fish without scaring people away from eating fish altogether.

An additional challenge for physicians is the evaluation of patients whose health problems may be attributed to, or exacerbated by, excessive dietary Hg consumption. Subpopulations at the higher end of the continuum of fish consumption include sport fishermen, commercial fishermen and their families, coastal and regional populations, Asian-Pacific islander and Native American populations, individuals pursuing a more healthy diet, and subsistence populations.

In addition to Hg, fish have variable concentrations of omega-3 fatty acids, as well as contaminants such as PCBs and dioxin. Because fish consumption is promoted as preventing heart disease and as good nutrition, many physicians have been advising their patients to increase fish consumption based on health benefits from omega-3 fatty acids. Consumer fish consumption advisories could be enhanced by making recommendations that emphasize which fish are high in omega-3 fatty acids but low in Hg, such as trout, shrimp, salmon, sardines, anchovies, etc. Additionally, alternatives to fish and shellfish tissue as a source of omega-3 fatty acids include fish oil-based dietary supplements. More comprehensive data are needed on the relative safety of these products with respect to Hg and other contaminants.

Some physicians will see patients who have excess Hg intake that might result in adverse health effects due to contaminants that may be present. The fish that are of most concern for coastal

populations, such as swordfish, shark, tile fish, and ahi and albacore tuna, have Hg levels similar to the Hg levels in the fish eaten by several cohorts where adverse developmental effects were detected. Environmental and dietary histories that encompass fish consumption should become part of a comprehensive health screen to identify those at risk for mercury accumulation. Sample case studies involving occupational and environmental history-taking are available on the Website of the Agency for Toxic Disease Substances Registry.[39]

The testing of mercury content in fish needs to continue. The results and advisories should be readily available where fish are sold to reduce the risk of mercury exposure during a lifetime of fish consumption. This approach needs to be combined with an effective message that serves to reduce consumption in those at risk while preserving consumption in those not at risk.

Questions remain about the long-term sequelae of early Hg exposure, the combined effects of inorganic mercury and MeHg, dose-response curves in adults, and the combined effects of multiple nutrients and neurotoxic substances. Long-term solutions to reduce dietary mercury exposure must rely on improving the quality of the food supply through reduced anthropogenic emissions of mercury that become incorporated into the food chain as MeHg.

RECOMMENDATIONS

The Council on Scientific Affairs recommends that the following recommendations be adopted in lieu of Resolution 516 (A-03) and the remainder of this report be filed:

1. Women who might become pregnant, are pregnant, or who are nursing should follow federal, state, and local advisories on fish consumption. Because these advisories may differ, the most protective advisory should be followed. **(New HOD Policy)**

2. Physicians should (a) assist in educating patients about the relative mercury content of fish and shellfish products; (b) make patients aware of the advice contained in both national and regional consumer fish consumption advisories; and (c) have sample materials available, or direct patients to where they can access information on national and regional fish consumption advisories. **(New HOD Policy)**

3. Testing of the mercury content of fish should be continued by appropriate agencies; results should be publicly accessible and reported in a consumer-friendly format. **(New HOD Policy)**

4. Given the limitations of national consumer fish consumption advisories, the Food and Drug Administration should consider the advisability of requiring that fish consumption advisories and results related to mercury testing be posted where fish, including canned tuna, are sold. **(New HOD Policy)**

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Table. New Data Compiled by the FDA on Methylmercury Concentrations in Fish

Mercury Data in Fish and Shellfish 2003[a]		
Fish	Mean Concentration (μg/g)	Range (μg/g)
Bluefish	0.318	0.139-0.479
Croaker	0.054	0.013-0.096
Grouper	0.569	0.072-1.205
Crawfish	0.028	0.014-0.047
Farm Raised Trout	0.033	0.015-0.110
Orange Roughy	0.485	0.013-0.762
Red Snapper	0.154	0.077-0.395
Trout, Seawater	0.328	0.022-0.744
Golden Tilefish	0.205	0.055-1.123
Whitefish	0.068	0.027-0.137
Black Seabass	0.127	0.058-0.352
Sardine	0.016	0.004-0.035
Albacore/white tuna	0.358	0.030-0.850
Light tuna	0.123	0.000-0.530

[a]Adapted from Schoeny R. The science behind the advisory. Mercury: Medical and Public Health Issues. April 29, 2004. Tampa, Fl.

Appendix

What You Need to Know About Mercury in Fish and Shellfish

2004 EPA and FDA Advice For: Women Who Might Become Pregnant
Women Who are Pregnant, Nursing Mothers, Young Children

Fish and shellfish are an important part of a healthy diet. Fish and shellfish contain high-quality protein and other essential nutrients, are low in saturated fat, and contain omega-3 fatty acids. A well-balanced diet that includes a variety of fish and shellfish can contribute to heart health and children's proper growth and development. So, women and young children in particular should include fish or shellfish in their diets due to the many nutritional benefits.

However, nearly all fish and shellfish contain traces of mercury. For most people, the risk from mercury by eating fish and shellfish is not a health concern. Yet, some fish and shellfish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish and shellfish eaten and the levels of mercury in the fish and shellfish. Therefore, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) are advising women who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and eat fish and shellfish that are lower in mercury.

By following these 3 recommendations for selecting and eating fish or shellfish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury.

1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.

2. Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.

    - Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.

    - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of albacore tuna per week.

3. Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

Follow these same recommendations when feeding fish and shellfish to your young child, but serve smaller portions.

Frequently Asked Questions about Mercury in Fish and Shellfish:

1. "What is mercury and methylmercury?"
   Mercury occurs naturally in the environment and can also be released into the air through industrial pollution. Mercury falls from the air and can accumulate in streams and oceans and is turned into methylmercury in the water. It is this type of mercury that can be harmful to your unborn baby and young child. Fish absorb the methylmercury as they feed in these waters and so it builds up in them. It builds up more in some types of fish and shellfish than others, depending on what the fish eat, which is why the levels vary.

2. "I'm a woman who could have children but I'm not pregnant - so why should I be concerned about methylmercury?"
   If you regularly eat types of fish that are high in methylmercury, it can accumulate in your blood stream over time. Methylmercury is removed from the body naturally, but it may take over a year for the levels to drop significantly. Thus, it may be present in a woman even before she becomes pregnant. This is the reason why women who are trying to become pregnant should also avoid eating certain types of fish.

3. "Is there methylmercury in all fish and shellfish?"
   Nearly all fish and shellfish contain traces of methylmercury. However, larger fish that have lived longer have the highest levels of methylmercury because they've had more time to accumulate it. These large fish (swordfish, shark, king mackerel and tilefish) pose the greatest risk. Other types of fish and shellfish may be eaten in the amounts recommended by FDA and EPA.

4. "I don't see the fish I eat in the advisory. What should I do?"
   If you want more information about the levels in the various types of fish you eat, see the FDA food safety website www.cfsan.fda.gov/~frf/sea-mehg.html or the EPA website at www.epa.gov/ost/fish.

5. "What about fish sticks and fast food sandwiches?"
   Fish sticks and "fast-food" sandwiches are commonly made from fish that are low in mercury.

6. "The advice about canned tuna is in the advisory, but what's the advice about tuna steaks?"
   Because tuna steak generally contains higher levels of mercury than canned light tuna, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of tuna steak per week.

7. "What if I eat more than the recommended amount of fish and shellfish in a week?"
   One week's consumption of fish does not change the level of methylmercury in the body much at all. If you eat a lot of fish one week, you can cut back for the next week or two. Just make sure you average the recommended amount per week.

8. "Where do I get information about the safety of fish caught recreationally by family or friends?"
   Before you go fishing, check your Fishing Regulations Booklet for information about recreationally caught fish. You can also contact your local health department for information about local advisories. You need to check local advisories because some kinds of fish and shellfish caught in your local waters may have higher or much lower than average levels of mercury. This depends on the levels of mercury in the water in which the fish are caught. Those fish with much lower levels may be eaten more frequently and in larger amounts.

For further information about the risks of mercury in fish and shellfish call the U.S. Food and Drug Administration's food information line toll-free at 1-888-SAFEFOOD or visit FDA's Food Safety website www.cfsan.fda.gov/seafood1.html. For further information about the safety of locally caught fish and shellfish, visit the Environmental Protection Agency's Fish Advisory website www.epa.gov/ost/fish or contact your State or Local Health Department. A list of state or local health department contacts is available at www.epa.gov/ost/fish.